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The Continuing Challenge of Aviation Safety in Africa.

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This study follows an epidemiological approach to examine possible predictors of and current interventions for safety in aviation transportation in two regions with widely different safety records: New York (NY) representing several regions in the US, and Tanzania (Tz), representing several regions in Africa. For most transportation modes, NY has one of the best and Tz has among the worst safety records. This paper identifies some of the similarities and differences between the two regions in order to find ways to improve the safety record in Tz and to ensure that safety continues to improve in NY.

Several US, African, and international public and private entities offer that safety is a serious and growing problem, with injuries accounting for approximately 1 in 8 deaths among males and 1 in 14 deaths among females worldwide (MacKenzie, 2000). In addition, they agree that with today's market globalization, to promote the economy and quality of life of one's own region, other struggling regions must also be enhanced. Local, national, and global connectivity is required for efficient commerce. Connectivity, in turn, requires ongoing security and safety. By improving transportation safety we may also find cost-effective ways to improve both the NY and Tz regions' economies and living standards.

NY is facing new economic, technological and safety challenges, such as those related to insufficient capacity in all modes of transportation. In NY, and across the US, congestion threatens safety, such as by runway incursions, and hampers economic growth by for example, increased delays or emissions pollution. "The great challenge is that of stimulating capacity growth through increased system efficiency, as infrastructure growth will likely be constrained" (Schubert, 2003).

This paper examined some predictors of safety in a preliminary manner, with the assumption that each region's problems and successes can inform the other. By describing factors such as international and government structures, safety culture, training and retention of the workforce, and statistical reports of accident data, we identify several safety predictors. We suggest that patterns of predictors may emerge that will solve the puzzle of why some regions continue to experience disproportionally high accident rates. Some predictors are common to all regions and modes, such as attempts to introduce and maintain a safety management system, a safety sub-culture, and implement advanced training. While technology improvements are necessary, they may not be sufficient to ensure transportation safety. Funding and government support remain challenges in both regions, although most officials and researchers agree that funding alone is insufficient to address all safety issues. Other predictors vary by context, modifiability and cost-effectiveness. Similarities in some of the accident rates can be found.

Our theoretical approach includes examination of the study variables from an epidemiological perspective, where three major levels of variables are examined (see Table 1). In addition, we suggest that competing hypotheses, particularly within the 'environment' level of our model, may serve to explain some of the observed differences in accident rates by world region.

We suggest that the persistence of high accident rates in East Africa in comparison to the US and specifically New York, is primarily related to the environmental level variable of economics (i.e. relative wealth) of each region. As a result of limited funding, the East African governments are constrained in terms of development of their infrastructure, regulations, policies, training and safety sub-cultures, safety management systems, and availability of technology and equipment.

If availability of funding is the issue, and we consider that New York is more economically advantaged than Tanzania, then:

In the more advantaged region, we assume that industry-leading technology and equipment would be more readily available and well-funded. Although we would expect to see accidents resulting from all three predictors in Table 1, in the more economically advantaged regions we expect a larger percentage of accidents resulting from the organizational and individual variables (i.e. policies and human factors issues). Additional resources for technologies and equipment may then only have relatively little impact on improving aviation safety in these advantaged regions.

In the disadvantaged region, technology and hardware improvements would have a relatively larger impact on aviation safety, as the more fundamental infrastructure issues may be present.

Table 1. Theoretical Model: Predictors and Outcomes for NY and Tz

Predictors and Interventions	Outcomes
Environment: Geography, climate, regulations, policies, economy, conflicts, general culture, energy, transportation infrastructure	Accidents, incidents, (violations, hazardous events)
Organization: Professional organizations, businesses, local transportation and safety sub-cultures, safety management system, technology, hardware, facilities	
Individual: Training types and levels, facilities, equipment, attitudes, licensing	

Methods

Findings related to aviation safety were drawn from a review of literature; secondary analyses of publicly available data; and from personal communications and internal reports, or reports specially generated for this study from government officials and researchers, mostly in Tanzania or South Africa (see Appendix A.) Because most information collected on Tz was not publicly available, the results present more information on Tz than NY. Next, we defined a testable model on best practices related to safety culture, government policies, and availability of technology. Our findings also suggested ways to design future data collection to test our theoretical questions about the persistent, high, aviation accident rate in Tz.

Results

The results are presented by comparing Tz and/or the five East African Community (EAC) countries with NY and/or the USA in terms of their overall economic status to determine their relative advantaged vs. disadvantaged status; their aviation accident rates to indicate the extent of the problems with safety; and examine the regions' environmental level variables' differences in terms of their infrastructure, policies and oversight; attempts to implement a safety culture; and their current initiatives to upgrade and improve their equipment and technologies, using the particular example of NextGen implementation for satellite based air traffic control and navigation systems.

Economic as indicators of advantaged vs. disadvantaged status

NY and USA are economically far more advantaged than Tz, as evidenced by the GDP of the US, which in 2010 was estimated to be $14.62 trillion and for NY, - $981 billion. In Tz the GPD was estimated at $US 22.43 billion. In 2010, the income per capita for the US was $47,400, for NY, $50,205 (2009), and in Tz it was $1,500 (www.cia.gov, www.cenus.gov, www.bea.ov, 2011).

Tz is the largest of the Eastern African countries, and has established a strong history of political stability. Agriculture and the services industries are the largest sectors of the economy. Tz has the most (6) World Heritage sites in sub- Saharan Africa, yet lags behind other countries in the region such as Kenya and South Africa in the development of the tourism sector.

However, the country has an aggressive plan to address deficiencies, which include full liberalization of the air transport industry (The Citizen, 2010). The government would raise the funds on its own and in concert with private investors. Restrictions will be removed on routes, capacity, code-sharing agreements, and tariffs, while strengthened government regulations and policy will ensure that operations meet international safety standards. While these plans are positive, Tanzania has had difficulty with other sectors' development and regulation. Bradford (2009) notes that the telecommunications sector showed uneven regulatory activity throughout its growth period, with a lack of resources that led to "under researched and under theorized" elements within regulatory governance.

Aviation accident rates indicate the extent of safety problems in NY and TZ

According to the International Air Transport Association (IATA), North America's hull loss (of Western-built jet aircraft) accident rate was 0.10 per million flights. In contrast, Africa had the worst rate in the world, 7.41. This rate was lower than the 2009 rate of 9.94, but the improvement is not considered sufficient by the global community. There were four hull losses with African carriers in 2010. African carriers are 2% of global traffic, but 23% of global western-built jet hull losses.

The 2010 global accident rate was 0.61, or one accident for every 1.6 million flights. This is a significant improvement of the 0.71 rate recorded in 2009 (one accident for 1.4 million flights). The 2010 rate was the lowest in aviation history, below the 2006 rate of 0.65. In the decade, 2001-10, the accident rate has been cut 42%. (www.iata.org, 2011).

The total number of Tanzanian air accidents, while small in absolute terms, represents a rate that highlights the need for safety improvements (see Table 2). Rates for 2007-9 are not yet published, but some details regarding the occurrences were provided by TCAA (2011). For example, in 2009 and 2010, most accidents involved Cessna aircraft. The pilot's ages ranged from 64 - 22, mean=30 years, while their flight hours ranged from 35-20,000, median of 1,700 hours (TCAA, 2009).

Table 2. Accident/Incident Performance in Tanzania

Occurrences	1995/96	2004/05	2005/06	2007	2009	2010
Departures by local & foreign airlines	38,796	79,727	78,213			
Passengers by local & foreign operators	784,635	2,031,359	2,302,105			
Accidents to local and foreign operators	6	5	3	3	0	1
Incidents to local and foreign operators	25	14	10	1	15	6
Fatal accidents	1	1	1	3	0	
Fatalities	1	8	5			
Accident rate per 100,000 departures –local	17.46	5.97	4.41			
Accidents/100,000 departures -local and foreign	15.47	6.27	3.83			
Incident rate per 100,000 departures –local	69.84	19.40	11.78			
Incidents/100,000 departures -local and foreign	64.44	17.56	14.06			
Fatal accidents/100,000 departures – local	2.91	1.49	1.44			
Fatal accidents/100,000 departures-local & foreign	2.58	1.25	1.28			
Fatality rate per 100,000 passengers –local	0.19	0	0.34			
Fatalities/100,000 passengers –local & foreign	0.12	0.39	0.21			

(TCAA, 2007, 2009, 2011; Personal Communication, 2006)

Although the accident rate has declined steadily over the eleven year period 1995-2006, the fatality rate for local operators remains about three times higher than that for foreign operators. Cumulatively, over this period, local operators were responsible for 2.12 and foreign operators for 0.72 fatal accidents per 100,000 departures. For incidents, local operators account for almost eight times the rate for the same period (12.64 for local vs. 1.64 for foreign operators) (TCAA, 2007).

By comparison, in 2005, US all transportation fatalities totaled 45,650, with highway accounting for most of the deaths, at 43,443 but 616 from aviation transportation (www.ntsb.gov, 2008). The aviation accident rate for all accidents in the USA in 2009 per 100,000 hours for Part 121 scheduled carriers was 0.149; for non-scheduled carriers, the rate was 0.753; for Part 135 carriers, commuters it was 0.685; and for on demand carriers 1.63; and for general aviation it was 7.20. A total of 534 people died from civil aviation accidents in 2009 (www.ntsb.gov, 2011).

Size of the aviation industries in the two regions

Not only is the accident rate in Tz higher than that of NY, its industry is also relatively smaller, especially when taking into account the population differences of the two regions as shown in Tables 3 and 4 below. The total number of pilots registered in Tz in 2008 was approximately 875 (Personal Communication, 2006; TCAA, 2009) and of those, there were approximately 600 pilots with a commercial certificate (see Table 3).

Table 3. Number of aviation professionals

Number of aviation professionals	Tanzania (2006/8)	US (2008/9)	NY (2009)
Population	37,445,392	307,006,550	19,541,453
Total Pilots	**997 (875 in 2008)**	**613,746**	**16,906**
Student Pilots	45	80,989	2,837
Private Pilots	301	222,596	7,382
Commercial Pilots	362 **(600 in 2008)**	124,746	3,645
Airline Transport Pilot	180	146,838	2,951
Total Non-Pilot Airmen	**30**	**678,181**	
Mechanics		326,276	
Air Navigation Services Engineers	21		
Air traffic Controllers	79	26,200	

(Personal Communication, 2006; TCAA, 2011; FAA, 2011)

There are relatively few domestically registered aircraft in absolute numbers or per capita, in Tz, in its neighboring EAC countries, and even in South Africa, which is the regional economic and transportation leader in comparison with those in NY and the USA (see Table 4).

Table 4. Domestically registered A/C by population & per capita for regions (2008)

Country	Population (millions)	Domestically registered aircraft	A/C Per 100,000 Capita
Tanzania	30	67	0.22

Kenya	30	175	0.58
Uganda	22	20	0.09
Rwanda	8.3	4	0.05
Burundi	6.4	4	0.6
EAC - Totals	100	275	0.28
South Africa	44	350	0.8
US Air Carrier	305.7	8,225	2.7
US General Aviation	305.7	224,352	73.4
USA – Totals	305.7	232,577	76.08

(Personal Communication, 2006, TCAA 2011, FAA 2011)

Other comparisons indicate that the Tz government does not fully fund the aviation industry and its infrastructure, which together with its absolute lack of equipment and technology, might contribute to Tz's higher accident rates.

Government funding for aviation in the United States consists of a combination of local initiatives and federal expenditures. The US FAA budget ($000) was $17,066,062 in 2009 (actual), $16,082,731 in 2010 (enacted) and $16,468,000 (requested) in 2011. In the 2011 requested budget, 'Safety' comprises ("000") $8,687,258 or 53%. The 2011 budget request provides a total of $1,143 million in technological support for 'NextGen'(www.dot.gov, 2011).

According to the TCAA, air travel in Tz is more expensive than in other countries in that region. The total Revenue for TCAA in 2006 was US$8,494 million, less total Operating Expenditure US$7,505 million. The Operating Expenditures were organized by administrative rather than program category, such as staff costs, repairs and maintenance, financial expenses (www.tcaa.go.tz, 2011). In the Tanzania Finance Minister, budget speech for 2010/11, the government allocated US$ 1,096.6 million to the infrastructure sector in FY-2010/11 budget, an increase of 12.7 % compared to FY-2008/09. The air industry was projected to grow by 7.9 % in 2009/10, but according to service providers, oppressive regulations, high taxes, levies, and poorly maintained runways and facilities prevented even greater growth (Toroka, 2010).

Capacity increases over the past decade as reported by the Official Airline Guide (OAG) (www.oag.com, 2011) reported in terms of the number of available seats worldwide, has increased 40%. The Americas and Europe showed moderate increases in capacity, with greater increases for Africa (11%), Asia (12%) and the Middle East (13%).

Similarly, for cargo, Africa is showing a strong growth rate: According to IATA, in 2010 Africa showed a much larger growth rate of cargo or freight traffic (28.5%) than North America and/or Europe (23.3%). Surprisingly, the Asia/Pacific growth at25.6% is less than Africa's (IATA, 2010). In absolute terms, however, the differences in size of the cargo industry are also large. In Tz approximately 1600 tons of cargo was transported in 2006 (www.nbs.go.tz, 2008), while in NY approximately 284,000 short tons of freight was transported in 2008 (www.bts.gov, 2008).

According to TCAA (2011), international aircraft movements increased by 5.9% from 23,593 in 2004/05 to 24,996 in 2005/06. This was a result of increased weekly frequencies by foreign airlines, from 67 to 78. The number of international passengers handled, increased from 914,446 passengers handled in 2004/05 to 1,021,822 in 2005/06. This was a result of operators using larger aircraft and increased frequencies.

Domestic traffic recorded an increase in aircraft movements of 5.6%, from the total of 123,420 movements in 2004/05 to 130,435 movements in 2005/06 and a 12.9% increase in passenger traffic, from 1,107,352 to 1,250,563 passengers in the same period.

Overall, aircraft movements increased by 5.7%, while passenger traffic increased by 12.4% between 2004/05 and 2005/06 (TCAA, 2011). Aircraft movements are expected to increase from 178,551 in 2008/09 to 192,620 in 2009/2010 (Toroka, 2010).

In the US, there were 35,143,152 foreign carrier enplanements and 733,836,574 total enplanements in 2008. In NY State there were 7,069,353 foreign carrier enplanements and 44,453,732 total enplanements in 2008. In the New York City metropolitan region, there were approximately 45 million total enplanements in 2008 and 42 million in 2009 (www.bts.gov, 2011).

New York has the dubious honor of being the leader in congestion related problems for the country. Almost 25% of all air traffic delays can be traced to this region (www.panynj.gov, 2011). Although there are battles over policy and budgets, all parties agree that the new technologies will help and, importantly, that safety could be compromised if the congestion issues are not resolved. Safety issues

related to congestion in the US include those related to aging infrastructure, airlines' financial stress and an increase in runway incursions (www.ata.org; www.faa.gov; www.panynj.gov, 2011).

In many parts of Africa, insufficient infrastructure development functions to reduce capacity for air travel, hampering regional economic development. To address these issues, the Ministry of Infrastructure Development developed 'Tanzania Vision 2025', which has goals similar to FAA's NextGen. The purpose of both countries' plans is to transform the current air transportation system, using, for example, satellite based navigation to replace radar to meet future air transportation needs. These initiatives are designed to improve safety, efficiency, environmental issues, integrate national defense, homeland security and address the economic needs of the global civil aviation industry (Personal Communication, 2006; TCAA 2011).

Thus, infrastructure development, whether congested or unfilled, must be addressed in order to promote economic development in both regions. Because of the impacts on policy, strategic planning and operations, infrastructure is considered as an environmental level safety risk factor for both regions. In Tz, however, the additional burden of economic obstacles to also improve technology and equipment would add to the safety problems and increase the overall accident rate in comparison to that of NY.

Implementing a safety culture.

There appear to be differences between Tz, and NY and USA in terms of their infrastructure, policies and oversight. Both the US and Tz conform to ICAO's plans to implement a safety culture, but may differ in terms of what technology exists and what policy steps are being taken. The 2010 ICAO meeting for the EAC highlighted 1) countries or states should establish and maintain effective and sustainable safety overflight systems and establish regional agencies for safety oversight and accident investigation, 2) aviation safety culture of African aviation service providers should be enhanced, and 3) a time frame for addressing deficiencies was to be established.

Tanzania, as with many African countries, faces economic pressures that might potentially derail any attempts to regionalize safety efforts. For instance, in 2005, Air Tanzania's operating license was suspended by the TCAA. TCAA's concerns centered on "compromised flight safety" issues that included improper aircraft inspections and shortage of qualified technicians and pilots. There was a real possibility that the airline would not recover and would cease operations (The Mercury, 2008).

In 2009 the Tanzania Minister for Infrastructure Development bemoaned the lack of qualified personnel in the aviation sector. Because this is a regional issue, the Minister implored the ICAO to support collaboration efforts to improve aviation safety in East Africa. Tanzanian officials pointed to a lack of policies, regulatory structure and the ability to retain qualified personnel as the main factors depressing safety statistics (Africa News, 2009). Bradford (2001) noted that the chronic shortage of qualified personal cannot be filled effectively with the use of expatriates.

Collaboration among the East African Community (EAC) is not always a given. A 2008 conference held in Arusha, Tz, showed that prior efforts to establish collective air traffic safety standards had not been fully ratified by any member nations except Uganda (BBC Monitoring Africa, 2008). Adequate funding is lacking in the EAC's push to improve air safety. In northern regions and in South Africa, air traffic control systems are long in place. Not coincidentally, many of these countries also have a history of regulation and enforcement. However, in much of the African interior, pilots are flying over vast areas of uncontrolled airspace. With large percentages of the population of these countries engaged in daily struggle to provide for their most basic needs, it is difficult for their governments to commit to costly technology projects such as satellite based air navigations systems. As recently as October 2010, the EAC's Civil Aviation Safety and Security Oversight Agency (CASSOA) addressed the funding issue. CASSOA is required to address deficiencies identified by ICAO but admits that neither they as an organization nor the individual member states, including Tanzania, possess the financial or technical abilities to address the deficiencies. ICAO agrees that a major hurdle to overcome is the lack of qualified personnel who typically leave for more lucrative positions upon completion of their training.

In the United States, safety management has a long history dating back to the 1940's. Lu, Wetmore, and Przetak (2006) noted that the FAA has advocated the use of System Safety protocols for the last 20 years for accident prevention and enhancement of safety management. The FAA's current approach to the implementation of a nationwide Safety Management System (SMS) is to develop a single set of rules for all branches of the industry rather than addressing each stakeholder's concerns on an individual basis. The FAA notes that most elements of inherent in an SMS are already employed within the industry (www.faa.gov, 2011; Flight International, 2008).

In summary, we demonstrate that there are persistent differences between NY and Tz in terms of their economies and their aviation accident rates, industry size and safety culture implementation

capabilities. We recommend that further research be conducted to more directly test the competing hypotheses derived from our theoretical model. We would collect data on causes of aviation accidents and incidents corresponding to the three levels of variables in our model in each region. Testing the model's competing hypotheses about the contributions of infrastructure and technology to safety in economically different regions would direct formation of cost-effective solution(s). Finally, verified prediction(s) and solution(s) could address the relationship between environmental, organizational and individual level variables to aviation safety in both economically disadvantaged and advantaged regions of the world.

REFERENCES

1. Air Transport Association,www.ata.org, retrieved August 2008
2. BBC Monitoring Africa, (2008). Uganda: East African regional body raps members over integration laws.
3. Bradford (2001) Indigenizing Organizational Change: Localization in Tanzania and Malawi; An African Centric Alliance. *Journal of Managerial Psychology*. Volume 16:1
4. Elsayed-Elkhouly, S. and Buda, R. (1997) A Cross-Cultural Comparison of Value Systems of Egyptians, Americans, Africans, and Arab Executives. *International Journal of Commerce & Management.* Volume 7
5. Ernest, S. (2010) Tanzania aviation plan will be global envy and (2009) Tanzania; Aviation operations threatened. in Africa News: The Citizen.
6. Lubner, M., Barton, M., Logie, A., Chen, G. (2008) "Preliminary examination of multimodal transportation safety, in Tanzania and New York, USA." *International Annual Roads Federation Conference*, Tanzania
7. Lu, C., Wetmore, M. and Przetak, R. *(*2006) Another Approach To Enhance Airline Safety: Using Management Safety Tools. *Journal of Air Transportation*. 11:2
8. MacKenzie, E. J. (2000). Epidemiology of injuries: current trends and future challenges. *Epidemiol Rev. 2000;22(1):112-9*, Retrieved December 12, 2007
9. Official Airline Guide (OAG), www.oag.com, retrieved February 28, 2011
10. Ott, J. (2001) Rising African safety culture paves way for new projects. *The East African (Nairobi*)
11. International Aviation Transport Association (IATA), www.iata.org, February 25, 2011
12. International Civil Aviation Organization (ICAO) www.icao.org, February 25, 2011
13. Port Authority of New York and New Jersey, www.panynj.gov, November 20, 2008, February 25, 2011
14. Personal Communication (2006) Kamhabwa, J. and Alloo, M. – see Appendix A
15. Toroka, E. (2010) Tanzania: stifling regulations, taxes play havoc with aviation business. *Business Times, Tanzania*, www.businesstimes.co.tz, retrieved February 27, 2011
16. Tanzania Civil Aviation Authority (TCAA) (2011), www.tcaa.go.tz, retrieved February 27, 2011
17. Tanzania National Bureau of Statistics (2011), www.nbs.go.tz, retrieved June 18, 2008
18. US Federal Aviation Administration, www.faa.gov, retrieved February 23, 2011
19. US Bureau of Labor Statistics, www.bts.gov, retrieved December 23, 2008, 2011
20. US Census, www.census.gov, quickfacts.census.gov, retrieved February 23, 2011
21. US Central Intelligence Agency, www.cia.gov, retrieved February 23, 2011
22. US Bureau of Economic Analysis, www.bea.gov, retrieved February 23, 2011
23. van Gorp, A. and Maitland, C. (2009) Regulatory Innovations In Tanzania: The Role Of Administrative Capabilities and Regulatory Governance. *The Journal of Policy, Regulation and Strategy for Telecommunications, Information and Media.* 11: 1
24. World Bank. Tanzania receives additional funding for local government support project. M2 Presswire. Coventry, retrieved June 18, 2008

APPENDIX A

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13. Mr. Prosper Tesha, General Director, Tanzania Airports Authority
14. ICAO – Safety and investigator officials
15. US DOT: librarian researchers, policy dept. interviews
16. Dr. Bill Bramble, US NTSB